the hairs slaty, with pale buffy tips. Crown of head like back. Dark orbital rings broad, strongly marked, extending forwards on to the sides of the muzzle. Cheeks and chin clearer buffy. Outer sides of arms and legs like back, inner sides like belly; hands and feet practically naked, pale brownish. Tail furry at its base for a shorter distance than usual, the fur, which is coloured like that of the back, extending for only about an inch and being surpassed posteriorly by the outstretched feet; remainder of tail naked, as usual, but instead of being white terminally it is uniformly pale brown to the end, at least above, the under surface being in one specimen slightly paler terminally.

Skull with well-expanded zygomata and broad interorbital region, with overhanging postorbital ledges. Teeth large, of the usual proportions in this group.

Dimensions of the type (measured in skin) :—

Head and body 187 mm.; tail 245; hind foot (s. u.) 23; ear 19.

Skull: basal length 39·5; greatest breadth 25; nasals 18·5 × 6·2; interorbital breadth 7·6; breadth across postorbital processes 9·4; breadth of brain-case 15; palate length 23·5; combined length of three anterior molariform teeth 7·7.

Hab. Sarayacu, Oriente of Ecuador.

Type. Female (young adult). B.M. no. 80. 5. 6. 77. Collected by Mr. Clarence Buckley. An old male also in collection.

This opossum shares with *M. regina* * alone of the present group the distinction of having a wholly brown tail, not turning to white at its end. From that species it is separated by its duller and less yellowish belly-colour, broader skull, and larger molars.

XVIII.—*On the Classification of the Crustacea Malacostraca.*

By W. T. Calman, D.Sc.

In the course of preparing a general account of the Crustacea for a forthcoming volume of Prof. E. Ray Lankester's 'Treatise on Zoology' I have been led to discard the commonly accepted classification of the Malacostraca and to adopt a scheme which was briefly outlined by Dr. H. J. Hansen some ten years ago. The object of the present

* Ann. & Mag. Nat. Hist. (7) ii. p. 275 (1898).

paper is to discuss somewhat more fully than is possible within the limits of a text-book certain of the facts bearing upon the case, to put into systematic form (with some modifications and additions) the classification suggested by Dr. Hansen, and to invite criticism of the result.

In 1815 Leach *, adopting a basis of classification which had previously been applied by Lamarck to the whole class of Crustacea, divided the subclass Malacostraca into two legions—the Podophthalma and the Edriophthalma—according to the condition of the eyes, movably pedunculate in the one and sessile in the other. Without attempting to summarize the numerous modifications which have been suggested, it may be said that Leach's classification has been accepted in principle by the majority of carcinologists since his time, and is that most generally followed at the present day. As originally defined, the two groups were sharply distinguished from each other not only by the characters given by Leach, but also by the presence in the Podophthalma of a cephalothoracic shield or carapace which was absent in the Edriophthalma, this character giving occasion for the names Thoracostraca and Arthrostraca applied to them by Burmeister †. The progress of research, however, rendered it increasingly difficult to form satisfactory definitions of the two divisions. In particular the recognition by Fritz Müller of a true, though reduced, carapace in the Tanaidæ and the elucidation of the structure of the Cumacea begun by H. Goodsir and by Kröyer provided intermediate links, the Cumacea, indeed, being placed sometimes in the one group and sometimes in the other. Claus ‡ established a third division (Leptostraca) for *Nebalia* and its allies, and the separation of the Stomatopoda from the other Podophthalma, first suggested, I believe, by Huxley §, left in the last-named group only the Schizopoda and Decapoda.

An important departure from the line of classification generally followed was made in 1883 by Prof. Boas ‖, who abandoned the group Schizopoda, pointing out that the Mysidæ and Lophogastridæ were by no means closely related to the

* "A Tabular View of the External Characters of Four Classes of Animals which Linné arranged under Insecta . . . . .," Trans. Linn. Soc. London, xi. (1815) pp. 306–400.

† 'Beiträge zur Naturgeschichte der Rankenfüsser,' Berlin, 1834, p. 55.

‡ 'Grundzüge der Zoologie,' 4te Aufl. (1880) p. 573.

§ Introd. Classification Anim. (1869) p. 125; Manual Anat. Invert. Animals (1877), p. 317.

‖ "Studien über die Verwandtschaftsbeziehungen der Malakostraken," Morphol. Jahrb. viii. pp. 485–579, pls. xxi.–xxiv. (1883).

Euphausiidæ, with which they had until then been associated. Boas divided the Malacostraca into seven orders—the Euphausiacea, Mysidacea, Cumacea, Isopoda, Amphipoda, Decapoda, and Squillacea. This view was severely criticised by Claus*, who, while admitting points of affinity between Mysidæ and Arthrostraca on the one hand, and between Euphausiidæ and Decapoda on the other, retained the Schizopoda as a central and primitive group, and classed them along with the Decapoda as Thoracostraca.

In 1893 Dr. Hansen†, in a preliminary account of his researches on the morphology of the appendages in Insects and Crustacea (not yet published in full), proposed a still further modification of the classification on the lines laid down by Boas, from whom, however, he differs on many points. While agreeing in discarding the group Schizopoda, Hansen points out that the Euphausiacea do not occupy the primitive position assigned to them by Boas, and he emphasizes their close affinity with the Decapoda, with which he proposes to associate them, opposing to the group thus formed another of equal rank, comprising the Mysidacea, the Cumacea, and the Edriophthalmate orders. Hansen's proposals seem to have attracted little attention, and I am not aware that any writer has adopted the classification suggested, though to me this arrangement of the Malacostraca appears to be the only one which adequately expresses our present knowledge of their morphology.

As Dr. Hansen does not give any names to the two groups which he defines, it may be convenient to state here that I propose the names PERACARIDA (πήρα, a pouch) for the division which includes the Mysidacea, Cumacea, Tanaidacea, Isopoda, and Amphipoda, and EUCARIDA for the Euphausiacea and Decapoda.

From this it will be seen that the chief point on which there is divergence of opinion is the retention of the Schizopoda as a natural group. That the Mysidæ present affinities with the Edriophthalma and the Euphausiidæ with the Decapoda is not disputed; but if we adopt Claus's view that the Schizopoda are a central group approximating to the stock from which the other orders have been derived, there is nothing to forbid their association with the other Podophthalma in our taxonomic arrangement. When, however,

* "Neue Beiträge zur Morphologie der Crustaceen," Arb. Zool. Inst. Wien, vi. pp. 1–108, pls. i.–vii. (1885).

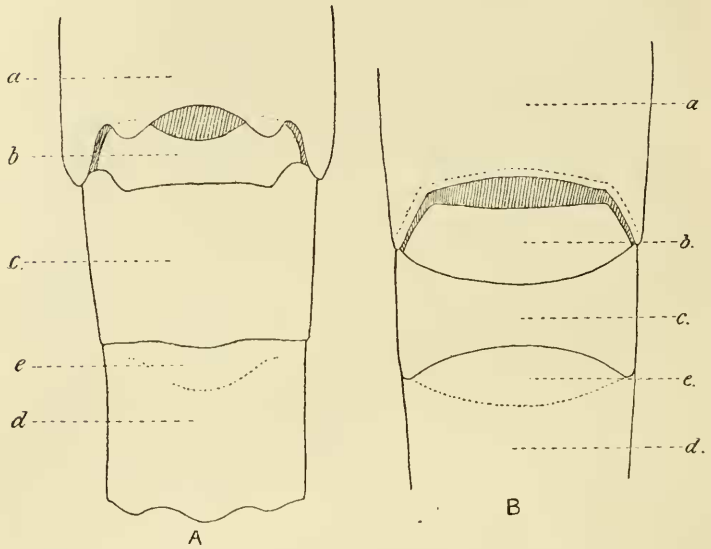
† "Zur Morphologie der Gliedmassen und Mundtheile bei Crustaceen und Insecten," Zool. Anz. xvi. pp. 193–198 & 201–212. Translated in Ann. & Mag. Nat. Hist. (6) xii. pp. 417–434 (1893).

we come to compare the characters (as given, for instance, by Sars *) of the Euphausiidæ on the one hand, with those of the Mysidæ, Lophogastridæ, and Eucopiidæ on the other, we find that, with one important exception, to be discussed presently, the two groups do not agree in one single character which they do not share with the lower Decapods, and for the most part also with the Stomatopoda and Leptostraca. They agree in possessing a carapace, movable eyes, a scale-like exopodite on the antenna, an elongated and ventrally flexed abdomen, and a "tail-fan" formed by the lamellar rami of the last pair of appendages displayed on either side of the telson. This combination of characters goes to make up what might be called the caridoid "facies," and at first sight strongly suggests affinity between the groups exhibiting it. It seems reasonable to suppose, however, that these characters, together with such others as the natatory exopodites of the thoracic limbs, are precisely what we must attribute to the hypothetical stock of the Malacostraca, and that the caridoid form has been retained in each of the divergent branches proceeding therefrom by those members which have adhered most closely to the primitive habits of life, and especially of locomotion. That the stalked eyes and the carapace are primitive features is not now disputed, nor can it be doubted that the possession of an exopodite on the antenna is also primitive, though it has been lost by the Leptostraca. The lamellar form of this exopodite is intelligible as an adaptation to swimming habits, and its reduction or loss corresponds fairly closely in most cases with diminished natatory powers. The fan-like disposition of uropods and telson is another character not shared by the Leptostraca, which, nevertheless, was probably possessed by the primitive Malacostraca, since it occurs in the lower Decapoda and the Stomatopoda, and also, though more or less modified, in Cumacea and many Isopoda. The retention of these primitive characters does not necessarily imply any special affinity between the various groups which exhibited them.

The one character, above referred to, which is stated to distinguish all Schizopoda from the Decapoda is the freedom of the terga of one or more of the posterior thoracic somites from the carapace. In the Mysidæ, Lophogastridæ, and Eucopiidæ at least five of these somites are complete upon the dorsal side and distinct from, although more or less overlapped by, the carapace. It has been stated that in the Euphausiidæ the last thoracic somite remains distinct, while

* Rep. Schizopoda 'Challenger,' pp. 10 & 11 (1885).

in the Decapoda all are coalesced with the carapace. If this were so it would constitute a strong, though not conclusive, argument in favour of retaining the Euphausiidæ in association with the other families of Schizopoda. As a matter of fact, however, this difference between the Euphausiidæ and Decapoda does not exist.



Junction of thoracic and abdominal regions of the body, from the dorsal side. A. *Nyctiphanes norvegica* (Euphausiacea); B. *Pandalus Bonnieri* (Caridea).

a, carapace; *b*, intermediate plate; *c*, tergum of first abdominal somite; *d*, tergum of second abdominal somite; *e*, articular surface defined by a groove on surface of second somite. The thorax and abdomen are drawn slightly apart, to show the area occupied by soft articular membrane between (indicated by shading).

If the junction of thorax and abdomen in a typical Euphausid such as *Nyctiphanes* be compared with the same region in one of the lower Decapoda (Penæidea or Caridea), a precise similarity of structure is found (see figure). The posterior margin of the carapace is concave on the dorsal side, leaving between it and the apparent anterior margin of the first abdominal somite an area of roughly lenticular outline, which is fully exposed when the abdomen is flexed, and is occupied by a firmly chitinized plate (*b*). Anteriorly this plate is overlapped by the carapace, with which it is connected by soft articular

membrane, and posteriorly it is firmly connected with the first abdominal somite. It is to all appearance quite comparable to thearticular surface (*e*) on the dorsal aspect of the other abdominal somites, which is concealed beneath the posterior margin of the somite in front when the abdomen is extended, and it only differs from these articular surfaces in being more sharply defined from the somite of which it forms a part. It is possible, though I know of no evidence to support the view *, that this plate is actually the tergal portion of the last thoracic somite, which has become detached from the sternal portion and has coalesced with the succeeding somite, but, in any case, the structure is exactly alike in Euphausiidæ and in the lower Decapods. I have carefully sought for other evidence of a distinct tergal element of the last thoracic somite in Euphausiidæ, but without success, and I can only conclude that the statement of its existence is an error based upon the observation of this intermediate plate without direct comparison with the Decapoda.

One point in which the Euphausiacea appear to agree with a section of the Mysidacea and to differ from the Decapoda is the possession of a single series of branchiæ at the bases of the thoracic limbs. In the Decapoda the gills are arranged in several (typically four) series. Those of the Euphausiacea are attached to the coxopodites of the limbs, corresponding to the podobranchiæ (and epipodites) of the Decapods, from which, however, they differ in their mode of branching. In the Lophogastridæ and Eucopiidæ, on the other hand, the gills are attached to the articular membrane at the base of the limbs, and are, in fact, arthrobranchiæ. As Claus has pointed out, this difference in the place of attachment does not necessarily invalidate the comparison between the branchiæ of the two groups, since he has shown that in certain Decapods the arthrobranchiæ develop as outgrowths from the basal portions of the limbs, and that the pleurobranchiæ had in all probability a similar origin. There is, however, another fact which may have a bearing on this question. In *Gnathophausia* (Lophogastridæ) Sars describes a small tongue-like process, tipped with a group of setæ, on the outer side of the coxopodite of all the thoracic limbs except the first pair, and he regards this as a reduced epipodite. It seems not unlikely that this process, and not the gill itself, is homologous with the epipodial gill of the

* Williamson figures this plate as a separate sclerite in the larva of *Crangon*. "On the Larval Stages of Decapod Crustacea.—The Shrimp (*Crangon vulgaris*, Fabr.)," Rep. Fishery Board Scotland, xix. (3) 1901, pl. v. fig. 156, "*in*."

Euphausiidæ. On the assumption that the primitive Malacostraca possessed at least two epipodial appendages on each thoracic limb (as in *Anaspides*), the distal series may have become modified as branchiæ in the Euphausiidæ and the proximal in the Lophogastridæ. In any case, the form of the gills differs considerably in the two cases, and the only point which they have in common as against the Decapoda is the arrangement in one instead of several series.

Among the characters in which the Mysidacea differ from the Euphausiacea and agree with the Edriophthalmate orders the most conspicuous is the possession by the female sex of a brood-pouch or marsupium, in which the eggs and young are carried. It cannot be doubted that this structure is homologous throughout the whole series which I have named, from this feature, the Peracarida, in spite of real or alleged differences in the mode of its development. It is formed by a series of overlapping plates (which Claus considers, with great probability, to be of the nature of epipodites) attached to the inner side of the coxopodites of some or all of the thoracic limbs. When, as in many Isopoda, the coxopodites are fused with the body, the plates are attached to the sternal surface of the somites. In some cases these plates or oostegites develop as bud-like outgrowths from the bases of the limbs, increasing in size at successive ecdyses as sexual maturity is approached; but in certain Isopoda it has been shown that the course of development is abbreviated, the oostegites growing in the space between the sternal cuticle and the hypodermis, and being set free, completely formed, at a single moult *. Probably some similar process has given rise to the statement that the oostegites arise by splitting of the ventral cuticle in the Cumacea † and in the Isopod *Gnathia* ‡. At the same time it is certain that the formation of the brood-pouch is profoundly modified in certain parasitic Isopods of the tribe Epicaridea. In many of these the oostegites develop in the typical fashion just described, but in the more specialized forms the structure is very different and hard to understand. In *Hemioniscus*, where the development has been worked out in detail by Caullery and Mesnil §, the marsupial cavity is hollowed out

* *Cf.* Leichmann, "Beitr. z. Naturgesch. d. Isopoden," Bibl. Zool. x. (1891).

† G. O. Sars, "Beskr. af de paa Freg. Josephines Exp. fundne Cumaceer," Kongl. Svenska Vet.-Akad. Handl. ix. 13 (1871), p. 19.

‡ Dohrn, "Entw. und Organ. v. *Praniza* (*Anceus*) *maxillaris*," Zeitschr. f. wiss. Zool. xx. (1870) p. 70.

§ "Recherches sur l'*Hemioniscus balani*, Buchholz . . .," Bull. Sci. France et Belgique, xxxiv. pp. 316–362, pls. xvii. & xviii. 5 figg. in text (1901).

in a thickening of the ectoderm on the sternal surface, and is from the first completely closed. Further research will be required to show what relation this cavity bears to the normal marsupium.

Apart from such exceptional cases, however, the possession of oostegites is a character quite peculiar to the group of orders included in the Peracarida and not found in any other Crustacea. It is true that the Euphausiidæ are described as carrying their eggs in sacs attached to the sternal surface of the thorax, and it has been assumed that these represent the marsupium of the Mysidacea. But, as Sars * has pointed out, the "ovisacs" are apparently formed by the consolidation of some cementing substance which is extruded along with the eggs from the oviducts. The rarity of ovigerous specimens would suggest that the eggs are so carried for only a brief period, while in some of the commonest species they have never yet been observed. This last circumstance is explained by an interesting observation for which I am indebted to Mr. E. W. L. Holt. In *Euphausia pellucida* Mr. Holt finds that the eggs when expelled from the body are not agglutinated together in masses, but are simply carried for a time between the thoracic feet of the female. In *Nyctiphanes Couchii* the egg-sacs have long been known. By the kindness of Mr. Holt I have been enabled to examine well-preserved specimens of both these species, and I find that, as, indeed, is implied by Sars's account, the structures found in *N. Couchii* are more properly described as egg-masses than as sacs, there being no definite enclosing membrane, but simply a film of hardened cement which also penetrates between and holds the eggs together. It is plain that this structure bears no morphological relation to the oostegites of the Peracarida. A very similar arrangement is found in the Decapod *Leucifer*, where, according to Brooks †, the eggs are "attached in a loose bunch of twenty or more to the last pair of thoracic limbs."

A feature which is very characteristic of the Peracarida, and one on which Boas and Hansen lay considerable stress, is found in the structure of the mandibles. In all the orders composing the series, with exceptions in the case of parasitic and other secondarily modified forms, an accessory blade, the *lacinia mobilis* of Hansen ‡, is developed just behind the

* Rep. Schizopoda 'Challenger,' p. 118.

† "*Leucifer*, a Study in Morphology," Phil. Trans. clxxiii. (1882) p. 60.

‡ The term *lacinia mobilis* was first applied by Hansen ('Dijmphna Togtets Zool. Bot. Udbytte' (1887), p. 197) to the accessory blade alone, but he afterwards extended its meaning to include also the row of spines

cutting-edge, and is followed by a row of serrated spines extending towards the molar process. In the Euphausiidæ and Decapoda no *lacinia mobilis* is found in the adult, though in the larvæ of both a group of serrated spines is sometimes present, which disappears in the course of development. Even in the adults of some of the more primitive Decapods, for instance in certain Atyidæ *, a tuft or row of stout bristles is found just below the cutting-edge, and it seems probable that this is a vestige of the spine-row of the Peracaridan mandible.

In distinguishing the Peracarida from the Eucarida, Hansen attaches great importance to certain characters presented by the thoracic limbs. Boas had already pointed out that the Mysidæ and the Edriophthalmate orders have these limbs terminated by a claw-like spine, which is absent in the Euphausiacea and Decapoda. Hansen regards this claw as representing a segment of the limb, and identifies it with the minute terminal segment which he has discovered in the Leptostraca. Boas had further indicated a difference between the two groups in the direction of the articulations of the limbs. In the Peracarida the "knee" or chief ventral flexure of the leg is between the fifth and sixth segments, counting from the base, while in the Eucarida it is between the fourth and fifth. Hansen interprets this difference in the following manner: he assumes that the position of the knee is the same in both cases, that the apparent fourth segment of the leg in Eucarida is equivalent to the fourth plus the fifth in the Peracarida, and that the three segments beyond the knee in the former case are homologous with the two segments and the terminal claw in the latter. If this suggestion be correct, we have a difference of a very marked kind between the two groups. Dr. Hansen will doubtless produce further evidence in its support when his researches are published in full, but at present there are difficulties in the way of adopting it as a basis for classification. In certain primitive Isopoda (Janiridæ &c.) the leg terminates in two, sometimes three, claws, not differing greatly in size or perceptibly in structure, and it is difficult to believe that one of them is to be regarded as the terminal segment while the others are simply modified setæ. Further, in many

---

which are often closely connected with it ("Cirolanidæ," Vidensk. Selsk. Skr. (6) v. (1890) p. 276, footnote). In the present paper I have used the term in its original and more restricted sense.

* *Cf.* Calman, "On Two Species of Macrurous Crustaceans from Lake Tanganyika," Proc. Zool. Soc. London, 1899, p. 705, pl. xxxix. fig. 5.

Peracarida the "claw" is coalesced with the segment which carries it, the suture-line between the two disappearing and the place of junction being indicated, if at all, only by the insertion of a minute seta, and it is not impossible that such evidence of the existence of a "claw" may yet be found in the terminal segment of the decapod leg. In the absence of any definite proof that the fourth segment of the leg in the Eucarida represents two fused segments, it seems better to assume for the present that the segments of the legs are serially comparable in the two groups.

Dr. Hansen includes among the characters of the Peracarida the presence of tubular processes for the orifices of the vasa deferentia, which are stated to be absent in the Eucarida. It is true that such processes are present in the majority of the Peracarida, though they are sometimes much reduced and may perhaps be altogether wanting in some cases. They are absent in the Euphausiacea and in the lower Decapoda, but in some Paguridea and in the Brachyura the vasa deferentia terminate in tubular processes which are often of considerable length.

The possession of spermatophores is another character on which it seems unsafe to rely as distinguishing the Euphausiacea and Decapoda from the other orders of Malacostraca. It certainly constitutes an important difference between the Euphausiacea and the Mysidacea, but it can hardly be extended without qualification to some of the other groups. Prof. Gilson applies the term "spermatophores" to the aggregations of spermatozoa found in certain Isopoda *, but not to the sperm-masses of the Macrura †. The distinction which Prof. Giard ‡ makes (in Insects) between spermatophores and "spermotagmata," according to the presence or absence of a definite investing membrane, appears to be hard to recognize among Crustacea and to have little systematic importance §. On the other hand, the form of the spermatozoa appears to afford constant and important characters differentiating the two groups.

* "Étude comparée de la spermatogénèse chez les Arthropodes," La Cellule, i. (1884) p. 158.

† *Op. cit.* ii. (1887) p. 187.

‡ "Sur la spermatogénèse des Diptères du genre *Sciara*," C. R. Acad. Sci. cxxxiv. (1902) p. 1124.

§ Prof. McMurrich describes ("Embryology of the Isopod Crustacea," Journ. Morph. xi. 1895, p. 67) a very definite spermatophore in the Isopod *Jæra* in connexion with the process of "hypodermic impregnation" which he believes to occur in that genus; but his account is not very detailed, and the phenomena which he describes are so remarkable that further investigation is much to be desired.

With regard to these and other points of internal anatomy our knowledge is very incomplete for many of the groups. Nothing is known of the internal anatomy of the Lophogastridæ, and very little regarding the Euphausiidæ and the lower decapods. One point which seems to tell against the system of classification here advocated may be given for what it is worth. This is the presence in all of the Podophthalmate groups (*Anaspides* ?, *Mysidæ*, *Euphausiidæ*, *Decapoda*, *Stomatopoda*) of an unpaired descending artery originating from the posterior end of the heart or from the base of the posterior aorta (superior abdominal artery) and perforating the nerve-cord to become connected with the subneural artery (sternal and inferior abdominal arteries). In the Edriophthalmate orders no similar arrangement is known, the subneural artery, where it exists, being connected with the dorsal portion of the vascular system by paired lateral arteries or by a circumœsophageal ring. In view of the great divergences which may exist in the disposition of the arterial trunks within the limits of a single order (*e. g.* the Isopoda), no great taxonomic importance can at present be attached to such differences.

Besides the characters, summarized in the definitions given below, which hold good throughout the various orders brought together in this classification, there are many connecting characters which serve to link together the individual orders and to indicate their affinities, although they cannot conveniently be included in our definitions. Many of these are discussed in the papers of Boas and Hansen, and we may simply mention as examples the retroverted palp of the maxillula in Lophogastridæ (Mysidacea), Cumacea, and Tanaidacea, the branchial epipod of the first thoracic appendage in the same orders, and the distinct, though immovable, ocular peduncles of the Tanaidacea. On the other side the Euphausiacea share with some suborders of the Decapoda the possession of an appendix interna on the pleopods, and the elaborate copulatory armature of the first pair of pleopods in the former group recalls that of the Penæidea in the latter, although differing in details. The larval development of the Euphausiacea runs closely parallel to that of the Penæidea, and Dr. Hansen's recent discovery * in a species of *Sergestes* of luminous organs resembling, though of somewhat different structure from, those of the Euphausiacea, helps still further to diminish the narrow space which separates the two.

* Proc. Zool. Soc. London, 1903, i. p. 72.

Since the papers of Boas and Hansen were written, the necessity for a rearrangement of the Malacostraca has been rendered still more urgent by Mr. G. M. Thomson's* discovery of *Anaspides*. This remarkable form presents a combination of characters which indicate for it a very isolated place in our classification. It is not merely a schizopod without a carapace. The double series of epipodial lamellæ, the segmentation of the thoracic limbs, the double gnathobasic lobes of the first pair, and the apparent distinctness of the first thoracic somite from the head† are among the characters which remove it from close affinity with any of the commonly recognized orders of Malacostraca. Though *Anaspides* is not by any means like the hypothetical ancestral malacostracan, its unmistakable resemblance to some of the oldest fossil Malacostraca (*Uronectes* &c.) shows that at least it is a very ancient type. In the classification given below I have regarded *Anaspides* and its fossil allies as constituting a division of equal rank with the Peracarida and Eucarida. For this I have adopted the name Syncarida, formerly proposed by Packard for the fossil forms alone.

The details which Mr. Thomson has given of the internal anatomy of *Anaspides* are very remarkable, and further investigation on this point is much to be desired. Unfortunately no specimens have yet reached this country in a state of preservation suitable for anatomical purposes. The mode of development is also quite unknown.

With regard to the other orders little need be said here. Claus's investigations‡ on *Nebalia* leave no doubt that the

* "On a Freshwater Schizopod from Tasmania," Trans. Linn. Soc. London, (2) Zool. vi. pp. 285–303, pls. xxiv.–xxvi. (1894). *Cf.* also Calman, "On the Genus *Anaspides* and its Affinities with certain Fossil Crustacea," Trans. Roy. Soc. Edinburgh, xxxviii. (4) pp. 787–802, 2 pls. (1896).

† I formerly suggested (Trans. Roy. Soc. Edinb. xxxviii. pt. 4, p. 787) that the "cervical groove" of *Anaspides*, which was described by Thomson as marking off the first thoracic somite from the head, really represented the line of junction of the mandibular with the maxillular somite, on the ground that owing to the forward direction of its lateral portions the lower ends come to lie just behind the mandibles. I am now disposed to doubt the correctness of this view. There appears to be a tendency in those Malacostraca which are without a carapace for the lateral plates (pleural or coxal) of the anterior thoracic somites to become displaced forwards at their distal ends as if to protect the mouth-parts: this is well seen in some Arcturidæ, for instance. It seems quite likely that this groove in *Anaspides* has undergone a similar displacement, and that it really does define the first thoracic somite, which is not distinct in any other Eumalacostraca.

‡ Especially "Ueb. d. Organismus d. Nebaliden und d. syst. Stellung d. Leptostraken," Arb. Zool. Inst. Wien, viii. (1889).

Leptostraca are intimately related to the Malacostraca, and their position seems best expressed by Grobben's * arrangement, which divides the subclass into two main groups, Leptostraca and Eumalacostraca.

The Stomatopoda must form a division of equal rank with the Eucarida and Peracarida. To preserve the consonance of names I propose to term it Hoplocarida. The morphology of the members of this group has been somewhat neglected, and their precise relationship to the other orders is by no means clear. Their internal anatomy is imperfectly known and would doubtless repay investigation †.

Classification here proposed.

Subclass MALACOSTRACA.

Series LEPTOSTRACA, Claus, 1880.

Division PHYLLOCARIDA, Packard, 1879.

Order *Nebaliacea*, nov. nom.

Series EUMALACOSTRACA, Grobben, 1892.

Division SYNCARIDA, Packard, 1886.

Order *Anaspidacea*, nov.

Division PERACARIDA, nov. nom.

Orders *Mysidacea.*
Cumacea.
Tanaidacea.
Isopoda.
Amphipoda.

Division EUCARIDA, nov. nom.

Orders *Euphausiacea.*
Decapoda.

Division HOPLOCARIDA, nov. nom.

Order *Stomatopoda.*

Series LEPTOSTRACA.—Abdomen of seven somites, the last of which is without appendages, and a telson bearing a

* "Zur Kenntniss des Stammbaumes und des Systems des Crustaceen," SB. Akad. Wien, ci. (1892) Abth. i. pp. 237–274.

† Kowalevsky states (Biol. Centralbl. ix. (1889) p. 41) that the maxillary gland ("shell-gland") is greatly developed in the Stomatopoda, but I cannot find any description of it. I have observed on the posterior surface of the maxilla in *Squilla mantis* a papilla with a minute terminal pore which may be the aperture of the duct of this gland, but I have had no opportunity of dissecting well-preserved specimens.

pair of movable articulated rami (caudal furca). An adductor muscle runs transversely between the two valves of the carapace. Thoracic limbs all similar, more or less foliaceous, with protopodite of three segments.

Series EUMALACOSTRACA.—Abdomen of six somites (the number may be reduced by coalescence), the last of which typically bears a pair of appendages, and a telson which never bears movable furcal rami *. No adductor muscle of the carapace. Thoracic limbs rarely all similar (Euphausiacea), typically pediform; protopodite of two segments, except in Stomatopoda.

Division SYNCARIDA.—Carapace absent. All the thoracic somites distinct. Eyes pedunculate. Antennal protopodite of two segments. Mandible without lacinia mobilis. Thoracic limbs flexed between fifth and sixth segments. No oostegites. No appendix interna on pleopods. Hepatic cæca numerous. Heart much elongated, tubular.

Division PERACARIDA.—Carapace, when present, leaving at least four of the thoracic somites distinct. First thoracic somite always fused with the head. Antennal protopodite typically of three segments. Mandible with lacinia mobilis (except in parasitic and other modified forms). Thoracic limbs flexed between fifth and sixth segments. Oostegites attached to some or all of the thoracic limbs in female, forming a brood-pouch. No appendix interna on pleopods. Hepatic cæca few and simple. Heart elongated, extending through the greater part of thoracic region, or displaced into abdomen. Spermatozoa filiform. Development taking place within the brood-pouch; young set free at a late stage.

Division EUCARIDA.—Carapace coalescing dorsally with all the thoracic somites. Eyes pedunculate. Antennal protopodite with, at most, two distinct segments. Mandible without lacinia mobilis in adult. Thoracic limbs flexed between fourth and fifth segments. No oostegites. An appendix interna sometimes present on pleopods. Hepatic cæca much ramified. Heart abbreviated, thoracic. Spermatozoa spherical or vesicular, often with radiating appendages. Development as a rule with metamorphosis. A free-swimming nauplius-stage in the more primitive forms.

* The movable appendages of the telson in Euphausiacea are modified setæ (Sars, 'Challenger' Rep., Schizopoda, p. 162).

Division Hoplocarida.—Carapace leaving at least four of the thoracic somites distinct. Two movable segments are separated from the anterior part of the head, bearing respectively the pedunculate eyes and the antennules. Antennal peduncle of two segments. Mandibles without lacinia mobilis. Posterior thoracic limbs with protopodite of three segments. (The relation of the segments of the anterior thoracic limbs to those of the limbs in the other divisions is doubtful.) An appendix interna on pleopods. Hepatic cæca much ramified. Heart much elongated, extending through abdominal and thoracic regions. Spermatozoa spherical. Development with metamorphosis. No free-swimming nauplius-stage.

BIBLIOGRAPHICAL NOTICES.

Memoirs of the Geological Survey of the United Kingdom.—The Cretaceous Rocks of Britain. Vol. II. *The Lower and Middle Chalk of England.* By A. J. Jukes-Browne, B.A., F.G.S. With Contributions by William Hill, F.G.S. 8vo. Pages xiii and 568. With 93 Illustrations, including one Geological Map, two Plates from photographs, and four from micrographs. E. Stanford, London; J. Menzies, Edinburgh; and Hodges & Co., Dublin. 1903.

In the first volume of this series A. J. Jukes-Browne and W. Hill, with others, described the Gault and Upper Greensand of England. This second volume, by the same authors, together with many contributors, deals with the Lower and Middle Chalk. The third volume will include the description of the Upper Chalk, with chapters on the economics of the soil, stone, &c., on the water-supply, and the physical features of chalk districts, also a complete catalogue of the fossils found in all the different divisions of the Chalk. The present volume begins with a general and chronological account of the researches that led to the definition of the several stratal divisions of the Chalk; and in the sequel the zones or horizons marked out by the occurrence of particular fossils are carefully explained. This part of the book seems to have been written before the valuable results of the researches by Rowe and Sherborn were published; these and their subsequent work along the cliff-sections of the Chalk will have greatly helped geologists in the study of the strata and zones, and are largely utilized in the chapters on the Middle Chalk.

The Lower Chalk ("Cenomanian" in part) includes all the beds